FDM 11-1-1 *Application of Standards*

July 31, 2006

1.1 Originator

The Chief of the Roadway Standards & Methods Section is the originator of this chapter. Questions and comments on the contents of this chapter should be directed to the following individuals.

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1.2 General

This Chapter includes the established standards and guidelines for application on all highways and streets being designed by or for WisDOT. The design information presented is based primarily on policies, standards, and specifications adopted by the American Association of State Highway and Transportation Officials (AASHTO). AASHTO publications are frequently referred to throughout this Chapter and are intended to supplement the design information presented. The letters GDHS will be used to represent various editions of the AASHTO publication "A Policy on Geometric Design of Highways and Streets."

The basic standards that govern the design and selection of traffic control devices are found in the latest edition of the U.S. DOT publication, "Manual on Uniform Traffic Control Devices for Streets and Highways" (MUTCD). This publication defines national standards and provides the necessary uniformity in application of control devices. The provisions of the MUTCD are further interpreted or modified by the Wisconsin DOT supplement to the MUTCD, and by specific provisions of this Facilities Development Manual. The purpose of traffic control devices and the warrants for their use, as stated in the MUTCD, is to help insure highway safety by providing for the orderly and predictable movement of all traffic.

The standards contained in this chapter represent the desirable and minimum values that are to be used for new construction, reconstruction and 3R projects. It is not intended, however, that these standards be inflexible. Use design values greater than the minimums where conditions permit and costs are not excessive.

Safety is a prime consideration in the development of all designs. However, engineering judgment must be used to determine the cost and safety effectiveness and the social and environmental impacts of the various design elements. Exceptions to standards may be justified on the basis of safety, cost-effectiveness and social and environmental considerations. These exceptions to standards must be fully explained and documented in the project records (see FDM 11-1-2 and FDM 11-1-4).

Do a complete engineering analysis of previous crashes and of the economic, social and environmental constraints imposed by natural and man-made features before deciding on a project's geometric design criteria. Financial constraints must also be considered. Part 625 of 23 CFR states "the determination to approve a project design that does not conform to the minimum criteria is to be made only after due consideration is given to all project conditions such as maximum service and safety benefits for the dollar invested, compatibility with adjacent sections of roadway and the probable time before reconstruction of the section due to increased traffic demands or changed conditions".

Application of geometric design standards to a particular project will depend upon the type of facility, nature of the project and the source of funding. The standards in this chapter apply to state-funded projects. FHWA has accepted them for federal-aid projects although FHWA also accepts the values given in the following documents.

1. Interstate Highways

   A Policy on Design Standards - Interstate System, 1991, AASHTO

2. Non-Interstate Highways

   (New Construction and Reconstruction): A Policy on Geometric Design of Highways and Streets (GDHS), 2001, AASHTO (Resurfacing, Restoration, Rehabilitation): FDM 11-40-1

3. Off System Roads

   Chapter V, GDHS

These documents will also apply to state-funded projects when the criteria are not addressed in this chapter.

Criteria for state funded rehabilitation type projects are contained in FDM 11-40-1. These apply to rural STH projects in the 3R Program that fall into the category of Resurfacing, Pavement Replacement, or Recondition. Criteria for urban projects, freeway rehabilitation, new construction, reconstruction and non-federally funded projects on local highway systems are contained throughout the rest of FDM Chapter 11.

Clear zone width for new construction and reconstruction projects shall be in accordance with FDM 11-15-1.

Pedestrian facilities shall be designed in accordance with the applicable sections of the Uniform Federal Accessibility Standards (UFAS). See "Accessible Public Rights of Way: A Design Guide," November 1999 for specific design requirements. This document is available on line at

http://www.access-board.gov/indexes/pubsindex.htm

FDM 11-1-2 Exceptions to Standards *June 5, 2008*

2.1 General

Despite the range of flexibility that exists with respect to virtually all the major road design features, there are situations in which the application of even the minimum criteria would result in unacceptably high costs or major impact on the human or natural environment. For such instances, when it is appropriate, the design exception process allows for the use of criteria lower than those specified as minimum acceptable values in Chapter 11 of the FDM. Formal approval is required for design exceptions to the 13 controlling criteria listed in Table 2.1 in accordance with approvals listed in Table 2.2. Projects on the National Highway System (NHS) must conform to the FHWA prescribed standards (as specified in 23 C.F.R. 625) regardless of the source of funding.

NOTE: FHWA's approval of design exceptions for all highway improvement projects on the NHS or Interstate System is considered to be a Federal Administrative Action (as specified in 23 CFR 771.107). The approval of design exceptions by FHWA is a Federal Administrative Action even if:

- The project does not utilize Federal-aid highway funding, and
- FHWA is not involved in the review and approval of project level environmental documentation for the purposes of complying with the National Environmental Policy Act (NEPA) requirements.

The determination to approve a project design that does not conform to the minimum criteria is to be made only after due consideration is given to all project conditions such as:

- Maximum service and safety benefits for the dollar invested,
- Compatibility with adjacent sections of roadway, and
- The probable time before reconstruction of the section due to increased traffic demands or changed conditions.

Exceptions may be given on a project basis to designs that do not conform to the minimum criteria, as set forth in the FDM or other applicable design manual, for:

- Experimental features on projects; and
- Projects where conditions warrant that exceptions be made.

2.2 Applicability

The provisions of this Procedure apply to improvements[i] on the following roads, regardless of who is designing, constructing, or administering the improvement, including improvements resulting from permits, Traffic Impact Analysis Reports, etc.:

- National Highway System (NHS) routes[ii], regardless of system, regardless of funding source; (http://www.fhwa.dot.gov/hep10/nhs/maps/wi/wi_wisconsin.pdf)
- STH, USH and Interstate routes, regardless of funding source;

- Connecting Highways[iii], regardless of funding source;
- Business Routes[iv], regardless of funding source;
- CTH routes, regardless of funding source;
- Town Roads, regardless of funding source;
- City or Village roads for improvements that have state or federal funding. (NOTE: City or Village roads that are not part of one of the above listed systems do not require WisDOT or FHWA approval for Exceptions to Standards on improvements that are 100% locally funded (i.e., no state or federal funding)).

2.3 Controlling Criteria

Formal exceptions to standards shall be processed whenever standards cannot be met for any of the controlling criteria shown in Table 2.1. For those criteria that are related to speed, the exception shall be based on the standards for the design speed for the appropriate segment of the project.

Table 2.1 Controlling Criteria

13 Controlling Criteria	Speed Related
1. Design Speed	*
2. Lane Width	
3. Shoulder Width	
4 .Bridge Width	
5. Horizontal Alignment	*
6. Superelevation	*
7. Vertical Alignment	*
8. Grades	*
9. Stopping Sight Distance	*
10. Pavement Cross Slope	
11. Vertical Clearance	
12. Horizontal Clearance	
13. Structural Capacity	

2.4 Approval Authority

Table 2.2 illustrates the level of approval that must be obtained for Exceptions to Standards. These levels of approval are determined based on the highway system on which the project is located. The approval is cumulative; i.e., an Exception to Standards must first be approved by the local unit of government (if applicable), then by the WisDOT region (if applicable), then by WisDOT DTSD BPD (if applicable), then by FHWA (if it is for an NHS route). Attachment 2.1 shows a flowchart of the approvals needed.

Table 2.2 Approvals for Exceptions to Standards

Highway or Road		Funding Source	Initial Approval(s)	Final Approval(s)
NHS route	STH, USH, Interstate [A]	ANY [B]	WisDOT Region [C]	(1) WisDOT BPD [C] (2) FHWA [D]
	Connecting Highway	ANY [B]	(1) City or Village (2) WisDOT Region [C]	
	Business Route on City, Village or Town road	ANY [B]	(1) City, Village or Town (2) WisDOT Region [C]	
	City or Village Road, non-Business Route, non- Connecting Highway	ANY [B]	(1) City or Village (2) WisDOT Region [C]	
	CTH	ANY [B]	(1) County (2) WisDOT Region [C]	
	Town Road, non-Business Route	ANY [B]	(1) Town (2) WisDOT Region [C]	
Non-NHS route	STH, USH	ANY [B]	WisDOT Region [C]	WisDOT BPD [C E]
	Connecting Highway	ANY [B]	(1) City or Village (2) WisDOT Region [C]	WisDOT BPD [C E]
	Business Route on City, Village or Town road	ANY [B]	(1) City, Village or Town (2) WisDOT Region [C]	WisDOT BPD [C E]
	City or Village Road, non-Business Route, non- Connecting Highway	State or Federal	(1) City or Village (2) WisDOT Region [C]	WisDOT BPD [C E]
	City or Village Road, non-Business Route, non- Connecting Highway	City, Village, or Private	City or Village	City or Village
	CTH	State or Federal	(1) County (2) WisDOT Region [C]	WisDOT BPD [C E]
	CTH	County or Private	County	WisDOT Region [C E]
	Town Road, non-Business Route	State or Federal	(1) Town (2) WisDOT Region [C]	WisDOT BPD [C E]
	Town Road, non-Business Route	Town or Private	Town	WisDOT Region [C E]

(A)The National Highway System (NHS) includes the Interstate Highway System.

(B) This includes funding from any source whatsoever, for example, the federal government, state government, local government(s), grants, private citizens and businesses.

(C) The Region Project Development Section (PDS) Chief is the Department's initial approval authority; the DTSD BPD Project Services Section Chief is the Department's final approval authority, except:

- The Region Local Project Manager is the Department's initial approval authority; the DTSD BPD Local Project Delivery Section Chief is the Department's final approval authority for projects administered by the DTSD BPD Local Project Delivery Section.
- The Region Director is the Department's final approval authority for Exceptions to Standards on non-NHS County Trunk Highways financed totally by a County (in accord with Administrative Code TRANS 205.04); and for Exceptions to Standards on non-NHS and non-Business Route Town Roads financed totally by a Town (in accord with Section 82.50(2)) Wis. Stats.

(D) FHWA is the final approval authority for Exceptions to Standards on the National Highway System (NHS), regardless of funding source.

(E) The approval authority for WisDOT must provide an informational copy to FHWA for Exceptions to Standards on Federal Oversight Projects that are not on the NHS[v].

2.5 Procedure

Requests for exception to design standards shall be submitted as separate documents in advance of the Design Study Report (DSR). Documentation accompanying the exception request must be complete and sufficient before it will be considered for approval.

All requests for geometric design exceptions prepared by the region Project Development Section (PDS) and approved by the region Project Development Chief shall be sent to the Project Services Section of the Bureau of Project Development (BPD). The Project Services Section will review the exception request for completeness and for approval. The Project Services Section will forward exception requests to FHWA if federal approval is required. The Project Services Section will inform the region whether the exception request has been approved or not.

Consultants are responsible for preparing requests for exceptions for those projects they are designing. Submittal requirements vary depending on who the Department's approval authority is (see Table 2.2 above).

1. If the approval authority is the chief of the DTSD BPD Project Services Section then exception requests shall be submitted to the appropriate region. The staff in the region will review the exception request for completeness and for approval. If the region approves the exception, it will then be forwarded to the DTSD BPD Project Services Section. The Project Services Section will also review the exception request for completeness andfor approval. The Project Services Section will forward requests for exceptions that require federal approval to FHWA for their review. The Project Services Section will inform the region who will then inform the consultant whether the exception request has been approved or not.
2. If the approval authority is the chief of the DTSD BPD Local Project Delivery Section then exception requests shall be submitted to the Management Consultant for the region. The Management Consultant will review the exception request for completeness but not for approval. If the review is satisfactory then the Management Consultant will forward the exception request to the WisDOT Region Local Project Manager. If the Region Local Project Manager approves the exception request then it will be forwarded to the DTSD BPD Local Project Delivery Section. The Local Project Delivery Section will review the exception request for completeness and for approval. The Local Project Delivery Section will forward exception requests to FHWA if federal approval is required. The Local Project Delivery Section will inform the Region Local Project Manager who will then inform the Management Consultant who will then inform the consultant whether the exception request has been approved or not.
3. If the approval authority is the Region director then exception requests shall be submitted to the appropriate region. The region will review the exception request for completeness and for approval. The region will inform the consultant whether the exception request has been approved or not.

Substantial deviation from certain controlling criteria may generate a request for field review. Region and consultant staff should allow time for such reviews when scheduling project activities.

2.6 Content of Request

Include the following information in a request for exceptions to standards:

1. Document the **existing highway conditions** and **proposed improvement** project in general terms. Discuss type and extent of work, project length, existing and design year AADT, percent trucks, anticipated future work, etc. Indicate if the road in question is a Long-Truck Route.
2. Thoroughly describe the **substandard feature(s)** providing specific data identifying the degree of deficiency; that is, provide speed ratings or stopping sight distance for horizontal and vertical curves, widths of driving lanes and shoulders, percent grades, etc. for proposed features and compare them to applicable standards. In most cases exceptions to standards are requested for existing features that will be retained. If they will result from reconstructing to something less than standards, please indicate that. Proposed design features should be compatible with programmed improvements of adjacent roadway segments.
3. Provide **crash data** and indicate the period of time for which the data applies. A 3-year minimum period should be used and it should be the latest period for which data is available. Breakdown crashes into property damage, injury, and fatality types when pertinent. Review crash reports as necessary.
    - Identify any high hazard locations.
    - Provide crash numbers and rate for the overall project, and for highway segments on the project. Compare the rate to the statewide average for that type of facility.

  - Provide numbers and severity (fatal, injury or property damage) of crashes attributable to each individual substandard feature.

4. Provide applicable cost data for alternative solutions.
   - Give the overall cost of the improvement project as proposed.
   - Present the additional cost to bring each individual substandard feature up to standards. Include construction, real estate and utility costs as applicable.
5. Describe other adverse impacts that would result from upgrading each feature to meet current standards. Provide specifics whenever possible (e.g. number of relocations, acres of wetland, acres of 4(f) land, types of effects upon historic sites, etc.)
6. Describe safety enhancements that will be made by the project. Examples include improved cross slopes, wider lane or shoulder widths, wider clear zones, etc. Specifically describe improvements that will address high crash locations. Include low cost mitigation features such as improved signing and marking, delineation, etc. Restoration of existing markings, etc., do not constitute enhancements. Discuss compatibility of the proposed improvement with adjacent roadways.
7. Include maps, charts, photographs, tables or other graphical data as necessary to enhance clarity and understanding and to reduce the length of the discussion.

2.6.1 Cover Sheets

2.6.1.1 Transmittal Letter

A memo submitting the Exception to Standards for approval is required. This is the only cover sheet required if WisDOT personnel prepare the Exception to Standards. Include signature blocks for all of the approval authorities listed in Table 2.2. Do not place these signature blocks within the report. Attachment 2.2 shows example formats for these memos.

2.6.1.2 Title Sheet

All Exception to Standards prepared by consultants and by local governments shall be sealed by a Wisconsin Professional Engineer. The purpose of this sheet is to identify the project and provide a standard location for the seal. This sheet is not required if WisDOT staff prepare the Exception to Standards. Project identification on this sheet should include the design I.D. number, route number or road name, Structure ID number (when structures are part of the project), and county. Attachment 2.2 shows an example format for the title sheet.

2.7 Metrics and Exceptions to Standards

Several figures in Procedures FDM 11-15-1 and FDM 11-40-1 show standards for county trunk highways and local roads. The English values given there are specified in TRANS 204, TRANS 205 or Section 82.50 (1) Wis. Stats. The metric values in these figures are slightly less than the corresponding English values. Therefore, in order to apply the metric values to the design of a county trunk highway or a local road project, the following paragraph should be added to the project's design study report in the section on exceptions to standards.

> We propose to use the metric standards specified in the Facilities Development Manual for this project. While these metric values are slightly less than those specified in (TRANS 204, TRANS 205 or Section 82.50(1) Wis. Stats), they are recognized as acceptable by the American Association of State Highway & Transportation Officials and the Federal Highway Administration. Furthermore, they are considered acceptable for state trunk highway projects. This is the only documentation needed to request approval to use the metric standards for a county trunk highway or local road project. Approval of the design study report is also approval to use metric-based standards.

2.8 Endnotes

i Section 84.06, Wis. Stats “Highway construction. (1) DEFINITIONS. In this section, “improvement” or “highway improvement” includes construction, reconstruction, rehabilitation, and processes incidental to building, fabricating, or bettering a highway or street, but not maintenance. The terms do not include the installation, replacement, rehabilitation, or maintenance of highway signs, traffic control signals, highway lighting, pavement markings, or intelligent transportation systems, unless incidental to building, fabricating, or bettering a highway or street.”

ii Agreement Between the Wisconsin Department of Transportation (Wisdot) and the Federal Highway Administration (FHWA) for Administration and Oversight of Federal-Aid Projects, Section IV. LAWS, REGULATIONS & CONTROL STANDARDS / PROJECT STANDARDS / Design Exceptions: “…Projects on the NHS must conform to the FHWA prescribed standards regardless of funding source. For most improvement projects, the location and degree of deficiency relative to the 13 controlling criteria are reported in the Design Study Report (DSR). All design exceptions should be analyzed, justified, reviewed and approved by the appropriate State or local agency for every highway improvement project, with FHWA providing final review and approval of all exceptions on the NHS." – ((Also in Appendix B, Approval Action: PRELIMINARY DESIGN (Design Phase) / Approve exceptions to design standards.)

iii Section 84.03(10), Wis. Stats "Federal aid; state and local funds. ..IMPROVEMENT OF CONNECTING

HIGHWAYS. All connecting highways shall be constructed or reconstructed by the state in the same manner as portions of the state trunk highway system. It shall not be compulsory for the state to construct or reconstruct any such highway to a greater width than those portions of the state trunk system connecting therewith."

iv Section 84.02 (6), Wis. Stats "State trunk highway system... ALTERNATE ROUTES THROUGH CITIES, VILLAGES AND TOWNS. In cases where any state trunk highway passes near but not through the central or business portion of any city, village or town, the department may upon petition of any city, village or town designate an alternate route through such central or business portion, and shall install suitable marking to guide travelers over such alternate route. No such designation shall be made unless the department finds that public travel will be benefited. Any such designation may be revoked on 30 days' notice to the city, village or town if the department finds that public travel is not benefited. Such designation shall impose no responsibility on the state, except the cost of marking in the first instance. Such alternate routes shall be constructed and maintained and kept clear of snow, in a condition satisfactory to the department without expense to the state, and the department may require assurances to that effect before making such designation."

v Agreement Between the Wisconsin Department of Transportation (Wisdot) and the Federal Highway Administration (FHWA) for Administration and Oversight of Federal-Aid Projects, Appendix B, Approval Action: PRELIMINARY DESIGN (Design Phase) / Approve exceptions to design standards / Federal oversight projects off the NHS (footnote 4): "Informational copy to FHWA required…"

The notes are applied as follows:
i. 1st sentence of section 2.2
ii. 1st bullet of section 2.2
iii. 3rd bullet of section 2.2
iv. 4th bullet of section 2.2
v. Note E under Table 2

LIST OF ATTACHMENTS

Attachment 2.1	Exceptions to Standards Approval Flowchart
Attachment 2.2	Exceptions to Standards: Sample Transmittal Letters & Title Sheet

FDM 11-1-3 Metrics and Design

March 9, 2005

3.1 Introduction

To comply with a federal mandate, WisDOT is converting its highway design and construction operations to metrics. The version of metrics to be used is known as the International System of Units (SI).

An international standard, called "ASTM E380," provides guidelines for the proper use of SI metrics. WisDOT has adopted that standard, except we use the American spelling of "liter" and "meter", rather than the French "litre" and "metre." This procedure contains basic descriptions of the units, conventions for writing the terms, and conventions for rounding and converting from the U.S. system.

3.2 The Basics

Simplicity is one of the great benefits of the metric system. All units are based on decimal mathematics. A kilometer is 1000 meters and a kilogram is 1000 grams (you'll understand later why there are no commas). No more eight pints to the gallon or 5,280 feet to the mile. No mils, inches, feet, yards, fathoms, rods, chains, furlongs, or miles. Here are some basics that apply to highway design:

1. **Meter** (m): The basic measure of distance in the metric system, a little longer than a yard.
2. **Liter** (L): The metric system's basic measure of liquid, a little larger than a quart.
3. **Gram** (g): For weighing small quantities. A paper clip weighs about a gram.
4. **Time** (s): The second, the basic measure of time, remains the same as in the U.S. system.
5. **Temperature** (°C): The basic unit of temperature is the degree Celsius. This scale defines the freezing point of water as 0°C and the boiling point as 100°C.
6. **Angles**: Although the radian is the metric unit of angular measure, WisDOT will continue to measure

plane angles using degrees (°), minutes (‘) and seconds (“).

3.3 Terminology

3.3.1 Special Units

These basic metric units have been used to develop special units of measure to describe other measurable attributes.

Table 3.1 Special Metric Units

Measurable Attribute	Unit	Symbol	Expression
Frequency of periodic phenomena	hertz	Hz	$Hz = s^{-1}$
Force	newton	N	$N = kg{\cdot}m/s^2$
Energy or work	joule	J	$J = N{\cdot}m$
Power	watt	W	W = J/s
Pressure or stress	pascal	Pa	$Pa = N/m^2$

3.3.2 Derived Units

Other measurable attributes can be expressed as combinations of the metric units listed above rather than creating more special units. Some of these are defined below:

Table 3.2 Derived Units

Measurable Attribute	Unit	Expression
Acceleration	Meters per second squared	m/s^2
Area	square meter	m^2
Density	kilogram per cubic meter	kg/m^3
Velocity	meters per second	m/s
Volume	cubic meter	m^3

3.3.3 Multiplication Factors

Sometimes, the units shown above are too large or too small to be practical for use in engineering calculations. To remedy this, metrics uses a series of prefixes to adjust the order of magnitude of its units. Some of the more common prefixes are listed below.

Table 3.3 Common Metric Prefixes

Prefix	Symbol	Order of Magnitude	Examples
mega	M	1 000 000	megapascal (MPa), megagram (Mg)
kilo	k	1000	kilogram (kg), kilometer (km)
milli	m	0.001	millimeter (mm), milliliter (mL)

3.4 Conversion Factors

The factors listed below are intended not only to allow the conversion of U.S. values to metric, they also give designers and surveyors a feel for the magnitude of metric units as compared to their U.S. counterparts. You will note that the metric unit "centimeter" does not appear in the conversion factor tables. The SI system does not recognize this as a standard unit of measure. Therefore, the unit "centimeter" will not be used in WisDOT projects.

Table 4.4 Conversion Factors (based on US Survey Foot*)

Class	Multiply	By	To Get
Length	in	25.4	mm
	U.S. survey ft	12/39.37**	m
	yd	36/39.37	m
	mi	1.609 347	km
Area	ft^2	$(12/39.37)^2$	m^2
	yd^2	$(36/39.37)^2$	m^2
	acre	4046.873	m^2
	acre	0.404 687 3	hectares (ha)
	mi^2	2.590 00	km^2
Volume	ft^3	$(12/39.37)^3$	m^3
	yd^3	$(36/39.37)^3$	m^3
	gal	3.785 412	L
	acre ft	1233.489	m^3
Mass	lb	0.453 592 4	kg
	ton	0.907 184 7	Mg
Mass/unit length	lb/ft	1.488 161	kg/m
Mass/unit area	lb/ft^2	4.882 408	kg/m^2
Density	lb/ft^3	16.018 37	kg/m^3
	lb/yd^3	0.593 272 9	kg/m^3
Force	lb	4.448 222	N
Pressure	psi	6894.730	Pa
Velocity	mph	0.447 040 9	m/s
Temperature	°F	(°F - 32) x 5/9	°C

* State Statute designates the U.S. Survey Foot (not the International Foot) as the recognized measure for length in Wisconsin. The U.S. survey foot is, by definition, exactly 12/39.37 of a meter.

** When used to convert U.S. coordinates (x, y, and z) or stationing to metric, this factor shall be carried to ten decimal places or 0.3048006096.

3.5 Conversion Guidelines

3.5.1 General

Conversion from U.S. to metric can be either exact ("soft"), or a suitable approximation ("hard"). A soft conversion transforms a U.S. value to an exact metric equivalent (e.g., 12 ft x 12/39.37 m/ft = 3.6576073152 m). A hard conversion transforms the U.S. value to a new, rounded, rationalized metric value that is convenient to work with (e.g., AASHTO has hard converted the 12-ft lane to a 3.6 m lane).

3.5.2 Significant Digits

A significant digit is a number that adds its own value to a larger number and is not just a place holder. The numbers 1-9 are always significant so the question becomes - when is zero a significant digit?

A zero is significant in the following situations:

- When it is enclosed by non-zero numbers (1.609 and 7025 both contain four significant digits).
- When it indicates the precision of a larger number.

Example:

58 has two significant digits while 58.0 has three. Caution: Do not add zeros after a decimal point of a number unless it can be justified by measurement or calculation. Adding unjustified zeros gives a false sense of a number's precision.

A zero is not significant in the following circumstances:

- When it is the only digit to the left of a non zero digit. Example: 0.53 and 0.053 both contain only two significant digits.
- When it is to the left of the decimal point but to the right of the right-most non-zero number. Example: 50 000 contains only one significant digit because, without more information, you can't tell if it has been rounded to the nearest unit or the nearest 10 000 units.

3.5.3 Rounding and Precision

The conversion of quantities or measurements must consider the relationship between the precision of the data and the given number of digits. This relationship is known as "implied precision." Implied precision assumes a number is rounded from one place right of its right-most significant digit.

Examples:

167 m is "assumed" to be rounded to the nearest whole unit so it represents a range of ±0.5 m or 166.5 m to 167.5 m.

5.2 kg is "assumed" to be rounded to the nearest tenth so it represents a range of ±0.05 kg or 5.15 kg to 5.25 kg.

100 N This number has only one significant digit because you don't know if it has been rounded to the nearest unit or tens or hundreds. Without any other information the best you can assume is ±50 N or 50 N to 150 N.

Sometimes the precision of a number is stated rather than implied and this affects how a number is rounded after being converted. For example, 125 ft normally is assumed to be rounded to the nearest whole unit and converts to 38.1 m. Both these numbers have three significant digits. However, if the 125 ft was rounded to the nearest 5 ft, then it has only two significant digits (the 1 and 2) and the converted value should also have only two significant digits (38 m). Finally, if 125 ft was rounded to the nearest 25 ft then it has only one significant digit (the 1) and the converted value should be rounded to only one significant digit (in this case 40 m).

In all conversions, the number of significant digits retained should assure that precision is neither sacrificed nor exaggerated. The primary rule to remember is maintain the precision of the converted value. As a general guideline, it is often effective to round the metric value to the same number of significant digits as used for the U.S. value. However, if this procedure reduces the precision of the converted value then the primary rule should control.

Examples:

5.2 mi X 1.609 347 km/mi = 8.3686 km round to 8.4 km. The rounded product has the same number of significant digits as the original U.S. value.

8.6 mi X 1.609 347 km/mi = 13.8404 km round to 13.8 km. The general guideline calls for rounding the product to two significant digits which would be 14. This, however, does not reflect the implied precision of the original value (rounded to the nearest tenth). This occurs because the converted value has been increased in order of magnitude from the whole units to tens of units. So, when the product of the conversion process results in an increase in the order of magnitude of the new value, then it is acceptable to increase the number of significant digits so the metric value has the same precision as the U.S. value.

When converting, use a conversion factor that is more precise than required, then round appropriately afterward. Rounding before multiplying will reduce accuracy.

Example:

Correct: 18.3 gal x 3.785 L/gal = 69.2655 L rounded to 69.3 L

Incorrect: 18.3 gal x 3.8 L/gal = 69.54 L rounded to 69.5 L

When starting with mixed U.S. units (feet and inches, pounds and ounces) express the U.S. quantity in the smaller U.S. unit before converting to metric and rounding.

Example:

10 feet, 3 inches = 123 inches

123 inches X 25.4 mm/inch = 3124.2 mm (round to 3124 mm)

When adding or subtracting, the answer must contain no significant digits to the right of the least precise number.

Example:

163 000

217 885

96 430

477 315 (round to 477 000 because the least precise number is rounded to the nearest thousand)

When performing general multiplication or division, the product or quotient must contain no more significant digits than does the number in the math process with the fewest significant digits.

Examples:

113.2 X 1.43 = 161.876 (round to 162 because 1.43 has three significant digits).

113.2 / 1.43 = 79.160 8 (round to 79.2 for the same reason as above)

3.5.3.1 Counts vs. Measurements

Sometimes a number means exactly what it says. This is true when counting discrete objects such as culverts or storm drain inlets. You don't deal with fractions of such items; their values will always be exact whole numbers.

Examples:

2.1 m3 riprap/culvert X 4 culverts = 8.4 m3 riprap. Since the number of culverts is considered exact, the riprap can be estimated to two significant digits rather than just one.

2.1 m3 riprap/culvert X 9 culverts = 18.9 m3 riprap. Remember the primary rule - maintain the precision of the value (in this case to the nearest 0.1 m3).

3.5.3.2 Rounding Values

When the first digit discarded is less than 5, the last digit retained is unchanged.

Example:

3.463 25 rounded to four digits would be 3.463; if rounded to three digits it would be 3.46.

When the first digit discarded is greater than 5 or is a 5 followed by at least one non-zero digit, add 1 to the last digit retained.

Example:

8.376 52 rounded to four digits would be 8.377; if rounded to three digits it would be 8.38.

When the first digit discarded is exactly 5 followed only by zeros, the last digit retained should be rounded to the nearest even number.

Example:

4.365 rounded to three digits becomes 4.36. The number 4.355 would also be rounded to 4.36 if rounded to three digits.

3.6 Writing Conventions

3.6.1 Names and Symbols

Unit names should be written in lower case (e.g., meter, kilogram, pascal). Exception - Celsius should be capitalized.

Most unit abbreviations should be written in lower case (e.g., mm, kg, m2). There are two exceptions to this:

- The abbreviation for liter is capital "L" because small "l" could be confused for a number "1."
- Symbols derived from proper names should be capitalized (N for newton, Pa for pascal and °C for Celsius).

Unit abbreviations should not end with a period.

Correct: m, mm, km, kg, MPa

Incorrect: m., mm., km., kg., MPa.

Unit names may be expressed in plural but unit abbreviations should not be expressed in plural.

Correct: 10 kilometers or 10 km

Incorrect: 10 kms

Leave a space between a number and its unit abbreviation.

Correct: 35 mm or 250 kg

Incorrect 35mm or 250kg

Exception: There should be no space between a number and the degree symbol, for either temperature or angular measurement.

Correct: 45°18'22" or 28°C

Incorrect: 45 °18' 22" or 28 °C

Do not leave a space between a decimal prefix and a unit abbreviation.

Correct: MPa, kg, mm

Incorrect: M Pa, k g, m m

When combining two units, use a raised dot between abbreviations and a hyphen between full names. Do not mix abbreviations and names.

Correct: newton-meter or N(m

Incorrect: newton(m or N(meter

When expressing a quotient of units, use a slash (/) between abbreviations but use "per" between full names.

Correct: meters per second or m/s

Incorrect: meters/second or m per s

3.6.2 Numbers

In general, dimensions less than 1.0 meter should be expressed in millimeters. Dimensions greater than or equal to 1.0 meter should be expressed as meters and decimals of a meter.

Correct: 75 mm or 3.6 m

Incorrect: 0.075 m or 3600 mm

Exceptions: All dimensions on structure plans shall be expressed in millimeters. When expressing a range of values that spans the 1.0 m threshold, use the unit of measure that best represents the range of values.

Correct: 750 - 1050 mm or 0.9 - 5.0 m

Incorrect: 750 mm - 1.050 m or 900 - 5000 mm

Use decimals, not fractions, to express partial units.

Correct: 2.5 m

Incorrect: 2½ m

Use a zero before the decimal point for values less than one.

Correct: 0.45 MPa

Incorrect: .45 MPa

Use a space to separate blocks of three digits for any metric number over four digits. Do not use a comma to separate the blocks.

Correct: 4371 kg, 45 138 kg

Incorrect: 4,371 kg, 45,138 kg

3.7 Metric Drafting Standards

WisDOT plans shall be prepared on the following metric-size sheets:

Full size: Metric sheet A1 (594 mm X 841 mm)

Reduced size: Metric sheet A3 (297 mm X 420 mm)

Stationing shall be based on 1000 meters per station with each station subdivided into twenty-five increments of 40 m each (rural) and 50 increments of 20 m each (urban).

The table below presents metric scales which should be used in lieu of the corresponding U.S. scales shown.

Table 3.5 Equivalent English and Metric Scales

Metric Scale	Engineer's Scale	% enlargement or reduction using metric scale
1:20	1"= 2'	+20
1:50	1" = 5'	+20
1:100	1" = 10'	+20
1:250	1" = 20'	- 4
1:500	1" = 30'	-28
	1" = 40'	- 4
	1" = 50'	+20
1:1000	1" = 60'	-28
	1" = 100'	+20
	Architect Scale	
1:2	1:2	-
1:5	3" = 1'0"	-20
1:10	1 1/2 " = 1'-0	-20
	1" = 1'-0	+20
1:20	3/4" = 1'-0	-20
	1/2" = 1'-0	+20
1:50	3/8" = 1'-0	-36
	1/4" = 1'-0	- 4
	3/16" = 1'-0	+28
1:100	1/8" = 1'-0	- 4

Cross sections shall be provided at 40 m intervals in rural areas and 20 m intervals in urban areas. Cross sections should also be provided for special situations such as the locations of side roads, driveways or culverts.

Pavement cross slope and superelevation shall be shown as percents.

Side slopes shall be expressed in non-dimensional ratios with the vertical component shown first.

For slopes <45°, the ratio should be expressed as 1:X.

For slopes >45°, the ratio should be expressed as Y:1 because the metric system does not use fractions.

Angular measurements shall continue to be shown in degrees, minutes and seconds.

Curves shall be defined in terms of radius rather than degree of curvature.

Curves originally defined by degree shall have their radius specified to the nearest millimeter.

Curves to be based on metrics initially shall have their radii established in 5 m increments.

The normal contour interval for aerial-based topographic maps is 500 mm.

Construction plans shall show only metric units.

Right-of-way plats shall be dual dimensioned with metric values shown first followed by U.S. values in parentheses.

Table 3.6 Plotting accuracy

Feature	Show to the nearest
Horizontal alignment data, section corner tie-ins, benchmark elevations, profile elevations	1 mm
Roadway elevations for vertical clearance computations	10 mm
Horizontal pluses, offsets, physical feature dimensions and locations	10 or 100 mm (10 mm preferred)
Elevations of ditch grades, pipe inverts, etc.	10 mm
Horizontal locations of driveways, culverts	1.0 m
Horizontal guardrail limits	500 mm

FDM 11-1-4 Programmatic Exception to Standards

April 26, 2007

4.1 Overview

A Programmatic Exception to Standards (PES) is a simplified way of avoiding upgrading certain substandard geometric features of a highway as part of a 3R (resurfacing, pavement replacement or reconditioning) highway improvement project. A PES differs from an individual exception to standards described in FDM 11-1-2. The individual exception to standards can be applied to any type of project. It requires a detailed analysis of the safety aspects of a section of highway as well as a benefit/cost analysis of upgrading any substandard feature.

A PES, on the other hand, is intended for 3R projects and it does not require as detailed an analysis as the exception to standards. Instead, it relies on a simplified safety screening analysis. If this analysis does not identify any substandard geometric features as contributing to crash problems, then these substandard features are not required to be upgraded. Of course, the substandard features may be upgraded if the designer feels there are extenuating circumstances.

Attachment 4.1 is the Programmatic Exception to Standards Report. It provides more detail on the PES concept and documents FHWA concurrence in its use.

4.2 Safety Screening Analysis

The Safety Screening Analysis (SSA) is a means of evaluating the crash history of a segment of highway to determine if substandard geometric features contribute significantly to any identified safety problems. If these features are shown to contribute to safety problems then they will be upgraded. If they are shown not to contribute to any safety problems, then they do not have to be upgraded as part of the 3R highway improvement project.

Using the SSA and PES approach on 3R projects offers several advantages.

- It provides a uniform and formal way of analyzing the safety aspects of a segment of highway.

- It identifies those highway segments that really need geometric improvements for safety reasons. These can be programmed separately and given higher priority.
- It allows more accurate estimates of cost, time and program impacts.
- It permits the use of an accelerated design process on certain segments of 3R projects

4.2.1 Application

The SSA may be used on any 3R project in the Existing Highways Program (Code 33) or Backbone Rehabilitation Program (Code 37), including expressways, freeways and interstate highways. This process may be used on urban projects as well as rural projects.

4.2.2 Timing

The SSA should be completed as early in the Facilities Development Process as possible, preferably while defining project concepts during project programming. This process should be done prior to consultant negotiations to ensure that the scope of services is as accurate as possible.

Ideally, the region System Planning and Operations staff will perform the SSA on the entire state trunk highway system within the region. Designers would then get the results from the SPO staff. If this is not possible, designers can perform the SSA on an individual section of highway that is the subject of a 3R project.

4.2.3 The Process

The Safety Screening Analysis uses a Meta-Manager (MM) Safety Analysis module and crash summary lists generated from the Department's vehicle crash reports. Highway segments with computed crash rates more than one standard deviation above that for similar highways are assigned Crash-type Flags that may be upgraded to Improvement Flags. The project is also screened using lists of individual crashes. Segments with high concentrations of crashes or high incidences of a particular type of crash are also identified with Improvement Flags.

The SSA may result in the elimination of the usual Exception to Standards Report for particular segments of highway when it is determined that the substandard geometric feature (if it is one of the thirteen controlling criteria found in FDM 11-1-2) does not contribute to lowered safety. These exceptions will be covered by the Programmatic Exception to Standards.

The SSA is described below and summarized in Attachment 4.2. Special terms used in this procedure are defined in the glossary provided in Attachment 4.3.

Step 1: Analyze project roadway using the Meta-Manager (MM) safety module.

This step involves reviewing accident data files on segments of highway and sorting the data into several key categories for further analysis. The result of this step is the labeling of each highway segment with either no flag, an Improvement Flag, or a Crash Type Flag.

To perform this step, the project highway is first divided into segments called Meta-Manager segments, currently named PDP ID in the data (see Attachment 4.4). They are derived from end points that correlate with segment termini from four files: Pavement Information File (PIF), Deficiency File (DF), the Financial Integrated Improvement Program System (FIIPS) and the Tradas Traffic Count System. The average length of a Meta-Manager segment is 0.86 miles.

Once the MM segments have been defined, access the MM data stored on the region or central office Local Area Network (LAN). The Excel workbooks and data description document are available on the region LAN at N:\Metamgr and also on the DTIM LAN at MAD00fpH\N8Public\Bshp\Meta-manager_data using the format:

Filename = ##_mmgr_data.xls   Where: ## = Region code

Step one uses the MM safety module, modified for this safety screening. To access this module:

1. Locate and open the spreadsheet as indicated above.
2. Click on the "Safety" tab on the bottom of the spreadsheet.
3. Under the Excel "Data" pull-down menu, choose "Filter" then "AutoFilter" to narrow in on the particular highway to be examined.

For information regarding the MM safety spreadsheet, please contact:

DTIM Meta-Manager Data Base Manager	(608) 264-8725
DTIM 3R and Low Cost Bridge Manager	(608) 264-8725

An example of the MM safety spreadsheet is shown in Attachment 4.4.

The Meta-Manager segments, scanned by the MM computer program, are labeled with either above- or below-normal crash rates in one of five crash categories:

1. Overall crash rate
2. Run off the road
3. Intersection
4. Other spot locations
5. Severe Injury/Fatality (A/K where A= Incapacitating and K= Fatal)

Note: Columns with heading “CRASHYRx” are numbers of crashes, not rates, and are not used in this analysis.

Meta-Manager segments with above normal crash rates in one or more of the five crash categories are identified with a 1 in the applicable column. These are called Crash Type Flags. Columns on MM segments with normal or below normal crash rates are identified with 0's and are not considered to be flagged.

Geometric improvements are not required for MM segments with Crash Type Flags that do not raise an Improvement Flag. While geometric improvements are not required, they should be programmed where appropriate. The engineer will also consider “Alternatives to Reconstruction to Enhance Safety,” as listed in FDM 11-40 Attachment 1.1 when Crash Type Flags are present or in other locations deemed appropriate by the engineer.

An Improvement Flag on a MM segment means a combination of Crash Type Flags suggests an engineered improvement may solve the crash problem on that segment. Segments with Improvement Flags will have a “Yes” in the last column of the safety spreadsheet.

Each segment with an Improvement Flag will have a number in the second last column of the safety spreadsheet. This number identifies the problem causing the improvement flag on the segment. Attachment 4.5 provides definitions for these numbers.

Those segments with Improvement Flags will require either reconstruction of the deficiency or a formal exception to standards (FDM 11-1-2) if the flag cannot be removed under Step 3.

After all the data is analyzed, enter information into the “Safety Screening Worksheet” located in Attachment 4.6.

Step 2: Manually review crash summaries

Step two involves manually reviewing crash summary lists of the project to identify crash concentrations or tendencies that may not have been picked up during the MM analysis. Obtain the crash summary list from the region Traffic Engineer. This step serves as a backup to computerized scanning and, while more subjective, it has the same weight in determining whether or not a MM segment should receive an Improvement Flag. Determine from the crash list whether there is a sufficient concentration of spot related type crashes or a sufficiently high incidence of crashes along the roadway, to justify labeling the MM segment with an Improvement Flag.

Table 4.1 Important Crash Report Columns

Crash Report Column	Definition
INTDIS	Distance from intersection in hundredths of a mile
ATHWY	Name of intersecting highway
ACCDSVR	Accident severity
ROADHOR	If on a horizontal curve a “C” will be coded
ROADVERT	If on a vertical curve (hill) an “H” will be coded
MNRCOLL	Manner of collision
DVRD01/2	What the driver was doing at the time of the crash

Considerable subjectivity is involved in interpreting the crash report. This can be minimized by using the Threshold Safety Table listed below. The table is based on a rate of 1.5 crashes per million entering vehicles. It can be used for either intersections or spot locations of the roadway. For intersections, use the ADT on both roadways unless side road is negligible.

Table 4.2 Threshold Safety Table

Mainline ADT (current)	Crashes Per Year
<750	0.5
1800	1.0
2700	1.5
3600	2.0
4600	2.5
5500	3.0
6400	3.5
7300	4.0
8200	4.5
9100	5.0

Annual Crash Rate (Crashes/Million Entering Vehicles) = Crashes/Year * 1,000,000 / (ADT * 365)

Example: STH project ADT at crossroad is 2200.

1. Threshold is 1.2 crashes per year (interpolated from table).
2. There were six crashes at the crossroad in four years or 1.5 per year.
3. The actual crash rate exceeds the threshold rate so an Improvement Flag should be raised.

All crash analysis will be recorded on the Crash Report Analysis Worksheet in Attachment 4.7 of this procedure. All additional segments identified with an Improvement Flag in this step shall be added to the Safety Screening Worksheet in Attachment 4.6.

Step 3: Evaluate Meta-Manager segments with Improvement Flags

This step involves a more in-depth study of roadway segments that have been assigned an Improvement Flag. The goal is to determine if the assignment of an Improvement Flag is actually valid for this segment. An Improvement Flag can be removed for either of the following reasons.

1. The segment does not contain any substandard geometric features for any of the 13 controlling criteria (See FDM 11-1-2) or,
2. It can be reasonably shown that substandard features do not significantly contribute to the types of crashes causing the problem.

Attachment 4.8 is a suggested process for conducting this Step 3 evaluation. The results of this process are also documented in Attachment 4.6.

If a segment can have its Improvement Flag removed then it can take advantage of the accelerated design process.

This third step should be performed during the programming process. It does, however, require some engineering data collection and analysis so a region may choose to either get project development and operations staff involved during the programming stage or delay this portion of the screening process until early in the design process.

Other Considerations

Both the MM and crash list analysis may result in non-assignment of an improvement flag when marginal crash problems are indicated. This may occur when the MM analysis produces crash type flags but the right combination is not present to produce an improvement flag or when either method produces an improvement flag which is removed due to an absence of substandard highway features. These commonly occur at intersections where a variety of non-geometric factors (e.g., poor signing or pavement marking) may be contributing to crash problems, or at spot locations where unique circumstances exist (e.g., trees shielding roadways preventing melting of ice, hidden driveways, compound curves that meet standards, etc.). In these instances, the person performing the safety screening analysis should try to determine the cause and, although not required by the process, should include corrective measures in the scope of the project whenever possible. These may be either low-cost or more traditional engineering type measures. A weakness of the screening analysis is that crash problems caused by non-geometric factors may not be detected. The safety analyst must be vigilant to ensure this does not occur.

Step 4: Document Findings

Document the results of the safety screening analysis in the Concept Definition Report. See FDM 3-5 Attachment 1.1 for the format. Place documents used to perform the safety analysis, including the safety screening worksheet, in the project folder. Designers can use them to resolve remaining low-cost safety improvements and enhancements.

4.3 Accelerated Design Process

Once a 3R project has been programmed, the actual design work can begin. See Attachment 4.2. As mentioned earlier, if programming staff have not completed Step 3 of the safety screening analysis, it needs to be completed early in the design phase. Those Meta-Manager segments that still have Improvement Flags after Step 3 is completed will have to follow the normal design process and address the non-standard geometric features of the MM segment. Those MM segments that do not have Improvement Flags can use the accelerated design process.

The main benefit of the accelerated design process is it does not have to fix sub-standard geometric highway features that do not affect the safety aspects of the MM segment. These segments also do not require a formal exception to standards for the substandard features because they are covered by the PES.

Step 1: Identify segments

The first step is to separate the segments with Crash Type Flags from the segments without Crash Type Flags. This information is available from the Meta-Manager Safety Spreadsheet as shown in Attachment 4.4.

Step 2: Incorporate operational improvements

All highway segments with Crash Type Flags require a minor amount of further crash and geometric analysis and documentation. Review the MM output and crash list to determine whether there is a high incidence of a particular crash type and determine the probable cause. This review will be done for both NHS and non-NHS projects. The design should then incorporate as many of the suggested operational improvements (See FDM 11-40 Attachment 1.1) into the final design as appropriate based on the analysis of crash types. These are the minimum upgrades that are required.

Substandard 3R design criteria are covered by the PES if they are not attributed to causing "Improvement Flags" for those particular segments. The 3R design criteria still applies to the project, but project-specific exceptions to design standards are not required. It should be noted the minimum geometric design criteria for 3R projects are intended to provide the lower limit for applying engineering judgment. The designer may incorporate geometric upgrades when appropriate. Any operational improvements or traditional engineering solutions identified during the safety screening should be incorporated.

Step 3: Incorporate safety enhancements

These are minimum safety enhancements the Department currently incorporates into 3R projects, and are included here for emphasis.

1. Superelevation and pavement cross-slopes will be improved as much as possible, even if not corrected to equal the current standards.
2. Beam guard will be improved by raising it, if necessary, to a height ranging from 24.5 to 27.5 inches between the shoulder surface beneath the rail and the top of the rail. Rails not connected to structures will be connected. Rails with post spacing greater than 6'-3" or with no block-outs will be replaced or upgraded. Rigid post cable guard and blunt-end beam guards will be replaced.
3. New pavement markings will be applied to any project that covers or obliterates the existing markings.
4. When roadway geometrics or roadside design are less than the 3R design standards, additional signs, markings, delineation and other traffic control devices beyond normal requirements in the MUTCD will be considered. See FDM 11-40 Attachment 1.1 for additional guidance.
5. For projects on the NHS, the following minimum safety enhancements will be provided, and are encouraged for all other highways:

- All beam guard will be upgraded in accordance with the guidance in FDM 11-45-1.
- Beam guard will be provided at all bridge approaches in accordance with the guidance in FDM 11-45-1.
- Culvert end sections greater than 36 inches (900 mm) in diameter that are within the clear zone as set forth in FDM 11-40-1 should be extended, made traversable, or evaluated for shielding with beam guard.
- Embankment slopes at side roads and driveways that are replaced or reconstructed should be 6:1 or flatter. When additional right-of-way is not required and culvert end sections or headwalls are replaced, they should be made traversable.

6. For projects on the Interstate and other NHS highways, the design must meet or exceed the minimum design criteria included in the PES Report (Attachment 4.1) unless formal design exceptions are approved. Designers are encouraged to meet or exceed these criteria on all other freeways, expressways and highways.

Step 4: Document the Project Design

The FHWA requires special documentation for 3R projects on the National Highway System if the routes have geometric features not meeting the 13 controlling criteria for 3R standards. The Design Study Reports for these projects must identify the approximate type, location and magnitude of these substandard features. This is necessary in order for these projects to be covered by the PES. Data available to the analyst for documenting the sub-standard features include: as-built plans, photolog output, State Highway Plan geometric model, uncontrolled surveys and controlled surveys when available. Documentation of the sub-standard features in the Design Study Report will include a statement that the substandard feature was not a significant contributing factor if no flags or only Crash Type Flags were identified on that segment.

LIST OF ATTACHMENTS

Attachment 4.1	Programmatic Exception to Standards Report
Attachment 4.2	Safety Screening Analysis and Accelerated Design Flow Charts
Attachment 4.3	Glossary of Items
Attachment 4.4	Sample Metamanager Safety Spreadsheet
Attachment 4.5	Improvement Flag Problem Descriptions
Attachment 4.6	Safety Screening Worksheet
Attachment 4.7	Crash Report Analysis Worksheet
Attachment 4.8	Suggested Step 3 Process

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[i] ***Section 84.06, Wis. Stats*** "Highway construction. (1) DEFINITIONS. In this section, "improvement" or "highway improvement" includes construction, reconstruction, rehabilitation, and processes incidental to building, fabricating, or bettering a highway or street, but not maintenance. The terms do not include the installation, replacement, rehabilitation, or maintenance of highway signs, traffic control signals, highway lighting, pavement markings, or intelligent transportation systems, unless incidental to building, fabricating, or bettering a highway or street."

[ii] ***Agreement Between the Wisconsin Department of Transportation (Wisdot) and the Federal Highway Administration (FHWA) for Administration and Oversight of Federal-Aid Projects***, Section IV. LAWS, REGULATIONS & CONTROL STANDARDS / PROJECT STANDARDS / Design Exceptions: "…Projects on the NHS must conform to the FHWA prescribed standards regardless of funding source. For most improvement projects, the location and degree of deficiency relative to the 13 controlling criteria are reported in the Design Study Report (DSR). All design exceptions should be analyzed, justified, reviewed and approved by the appropriate State or local agency for every highway improvement project, with FHWA providing final review and approval of all exceptions on the NHS." – ((Also in Appendix B, Approval Action: PRELIMINARY DESIGN (Design Phase) / Approve exceptions to design standards.)

[iii] ***Section 84.03(10), Wis. Stats*** "**Federal aid; state and local funds**. ..IMPROVEMENT OF CONNECTING HIGHWAYS. All connecting highways shall be constructed or reconstructed by the state in the same manner as portions of the state trunk highway system. It shall not be compulsory for the state to construct or reconstruct any such highway to a greater width than those portions of the state trunk system connecting therewith."

[iv] ***Section 84.02 (6), Wis. Stats*** "**State trunk highway system**... ALTERNATE ROUTES THROUGH CITIES,

VILLAGES AND TOWNS. In cases where any state trunk highway passes near but not through the central or business portion of any city, village or town, the department may upon petition of any city, village or town designate an alternate route through such central or business portion, and shall install suitable marking to guide travelers over such alternate route. No such designation shall be made unless the department finds that public travel will be benefited. Any such designation may be revoked on 30 days' notice to the city, village or town if the department finds that public travel is not benefited. Such designation shall impose no responsibility on the state, except the cost of marking in the first instance. Such alternate routes shall be constructed and maintained and kept clear of snow, in a condition satisfactory to the department without expense to the state, and the department may require assurances to that effect before making such designation."

[v] ***Agreement Between the Wisconsin Department of Transportation (Wisdot) and the Federal Highway Administration (FHWA) for Administration and Oversight of Federal-Aid Projects***, Appendix B, Approval Action: PRELIMINARY DESIGN (Design Phase) / Approve exceptions to design standards / Federal oversight projects off the NHS (footnote 4): "Informational copy to FHWA required…"